



Solutions for EUV Mask Inspection

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Agenda

- 630 with Adv EUV roadmap
- 630 with Adv EUV performance
- Role of APMI in EUVL
- 7xx roadmap
- 7xx System concept
- 710 Performance Estimates
- Summary

Teron 630 Adv EUV Mask Inspection System

Major extension of Teron 610 platform based on new RET technology, designed to meet mask shops' EUV reticle inspection needs for 22 HP & 14 L

■ Target Applications

- Pattern inspection for next-gen EUV mask manufacturing
 - Development & production for 22 HP & 14 L reticles
 - Development for EUV masks to 18 nm HP
 - Phasur2 for ML blank inspection to 18 nm hp
 - Concurrent EUV CDU for mask process improvement and reticle correction on scanner



■ Key Attributes

- High sensitivity DD and DB capability
- 2 - 4 hour scan time → fast learning cycles
- Variable illumination & polarization in R → defect signal boost
- Major enhancements in DB modeling → lower noise
- Unique new EUV detectors for best defect capture
- EUV dual pod mask handling / Class 1 cleanliness

Teron 630 EUV Schedule

1 st Images	Feb 2011
1 st Scans	Sep 2011
1 st Demos (Beta)	May 2012
1 st Shipment	Sep 2012

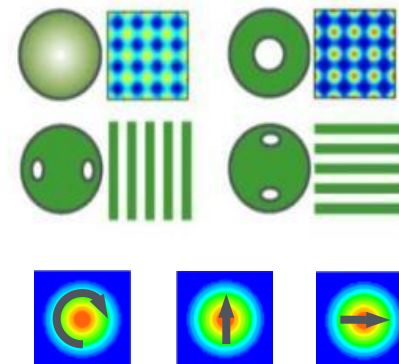
1st Teron 630 with Adv EUV Shipped 25-Sept-12



630 – Next Gen Platform for 22 HP / 14 L EUV

- Extensive changes to the 600 H/W platform
 - New optics – Increase signal to noise
 - New stage / loader – EUV mask handling
- Significant noise reductions
 - Vibration & A/F error reductions
 - Low aberration optics
 - Breakthrough in Algo modeling techniques
- Significant advancements in cleanliness
 - ISO Class 1 dynamic
- More S/W improvements in-process
 - High performance DD, Black Border inspection, EUV CDU, etc.

Four 630 Systems Scanning



Flexible Illumination

Flexible Polarization

Cleanliness Performance of Teron 630

Target: ≤ 1 adder @ 30 nm with 20 cycles, frontside

Problem Statement: EUV masks are unlikely to have a pellicle to protect them from fall-on contamination. From final cleaning, through final inspection (OQC) and placement into the EUV Dual Pod it is therefore critical to maintain an ultra-clean environment.

Test Outline:

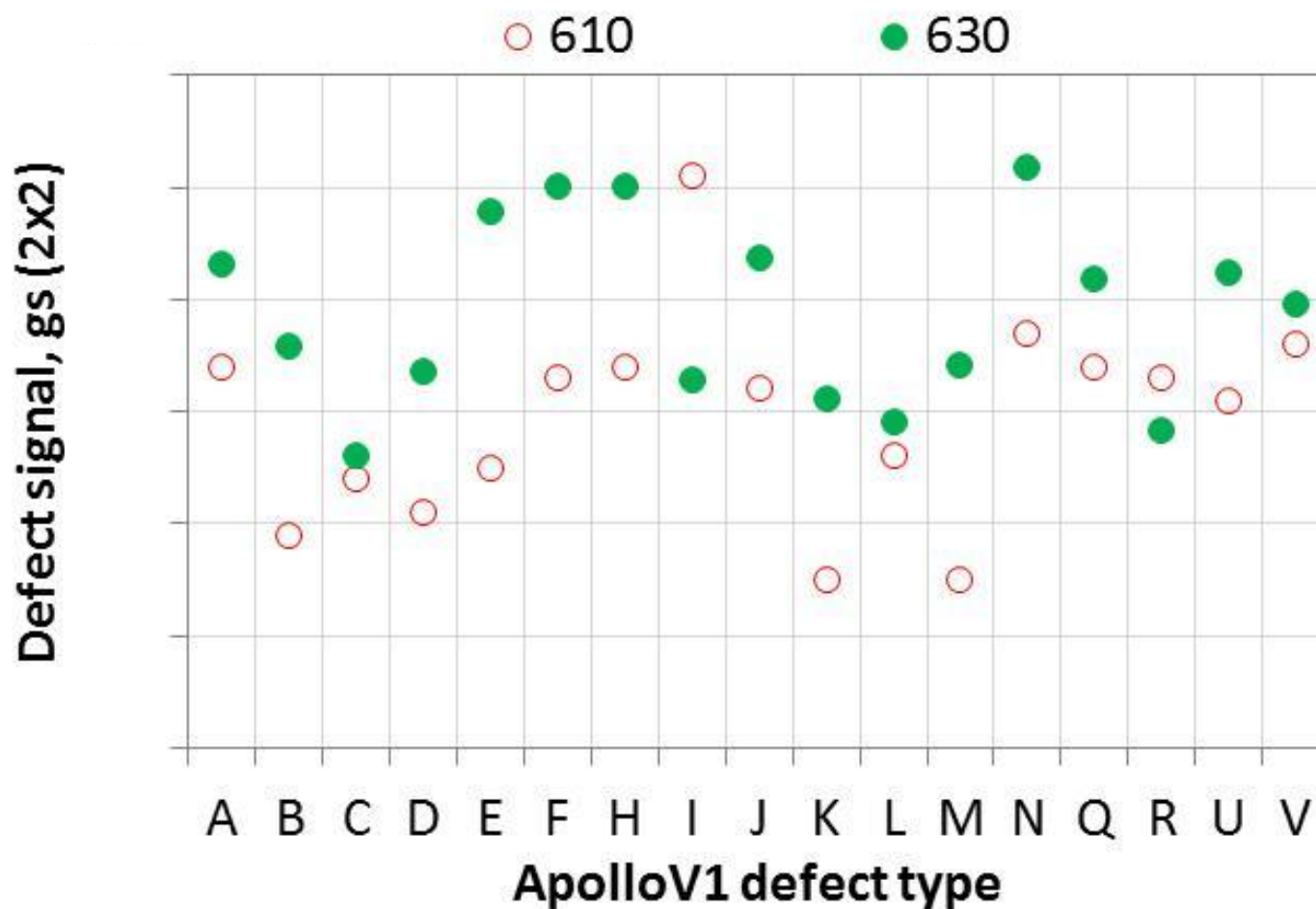
- Scan 140 mm² of an unpatterned EUV (or Cr) blank, using new Particle Mode to establish baseline.
- Starting from RSP200 pod (or Dual Pod), transfer mask to Pre-Aligner, then Stage, and back. Each cycle requires ~ 11 min.
- Re-scan blank and determine adders.
- Particle mode capable of capturing 30 nm SiO₂ spheres > 99% capture rate.

Results

<u>Tool</u>	<u># Cycles</u>	<u>Adders > 30 nm</u>
A	20	0
A	20	0
A	52	1
A	100	0
B	80	0
C	20	0
C	100	0

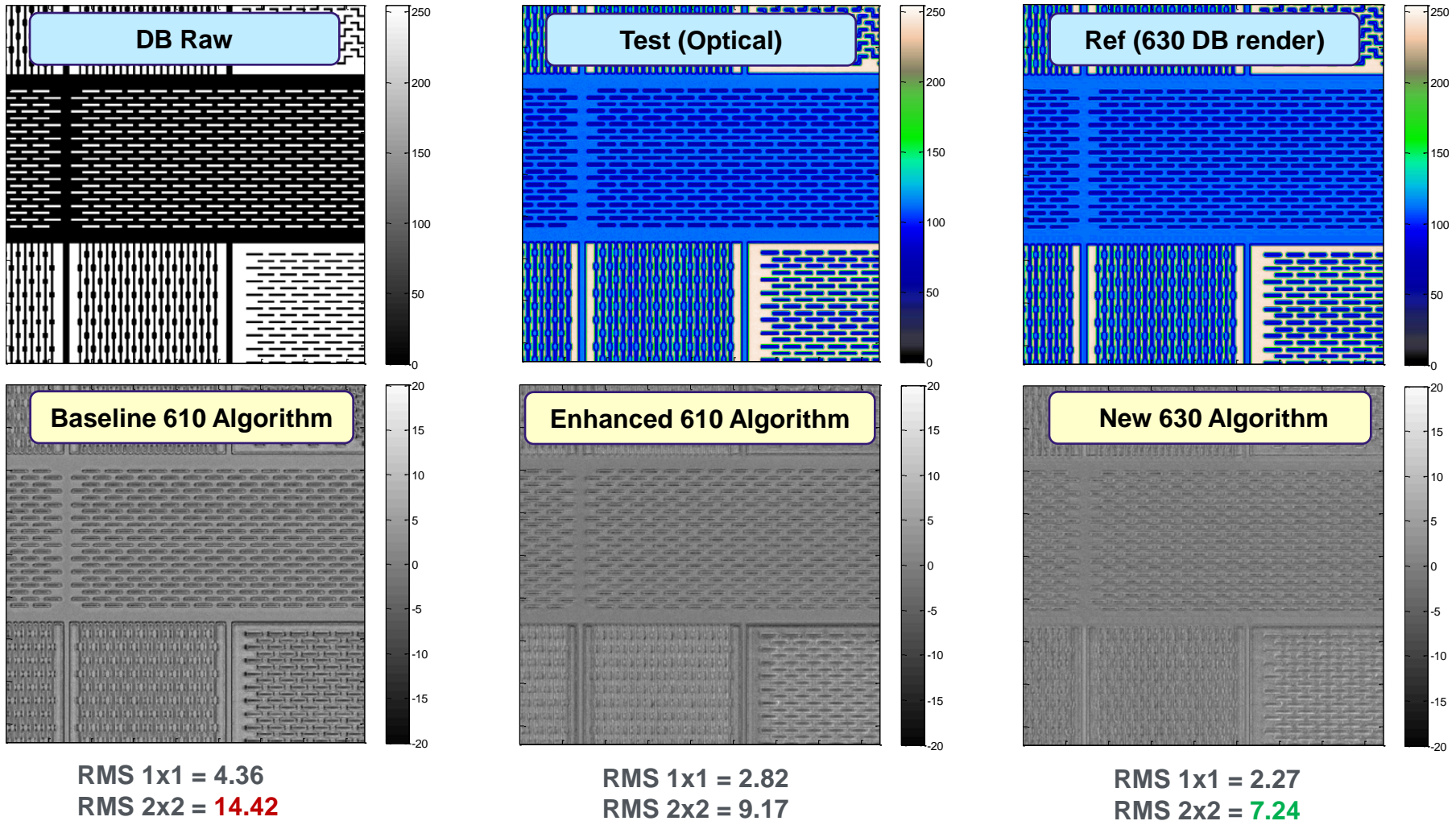
Defect Signal Improvement on Apollo

Typically 10 – 50% improvement demonstrated



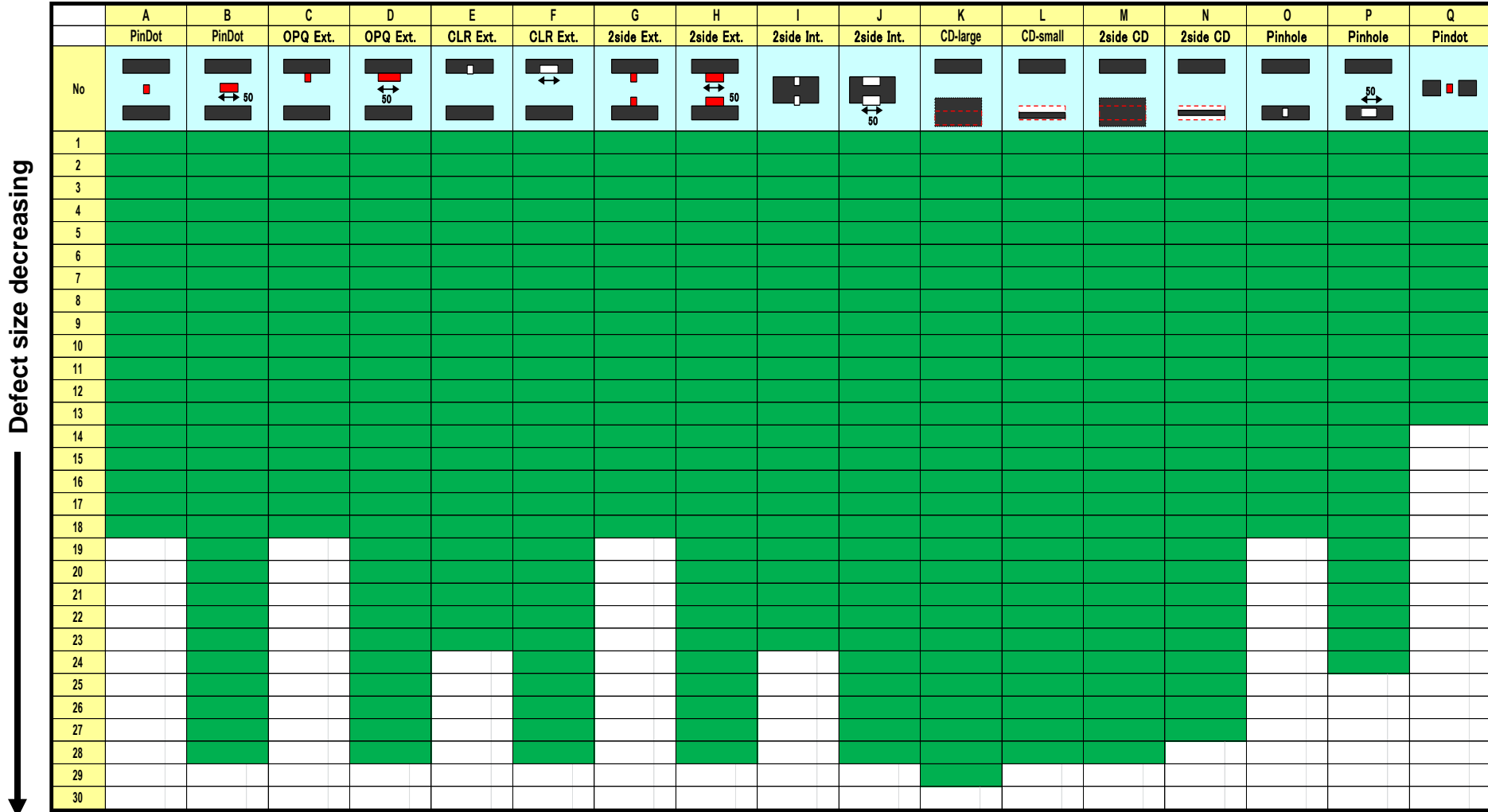
Modeling – 2X improvement in DB Rendering

Base pattern error by algorithm on EUV Titan




Teron 630 extension below 22 nm hp possible

@18 nm hp: low modulation but good sensitivity

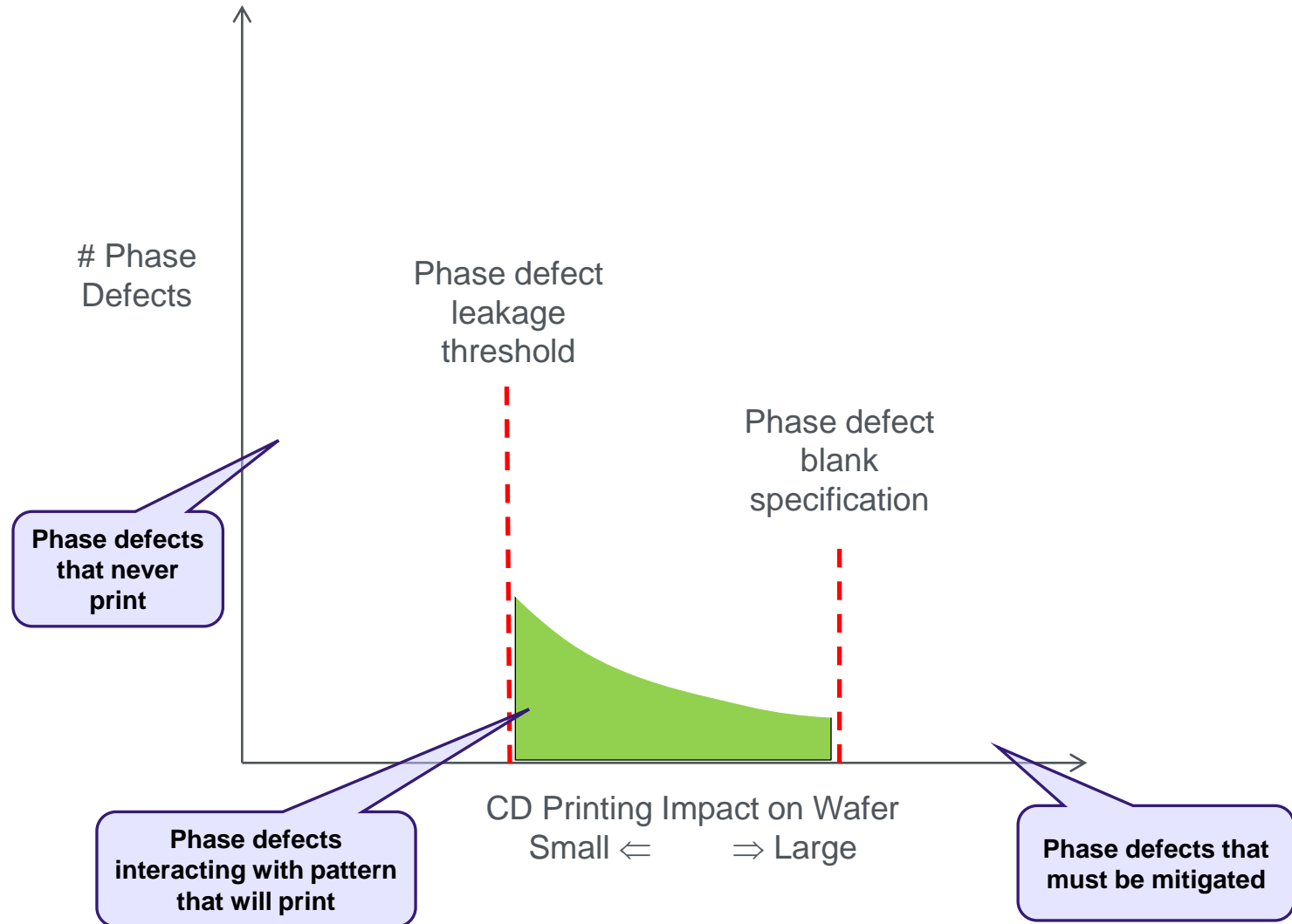


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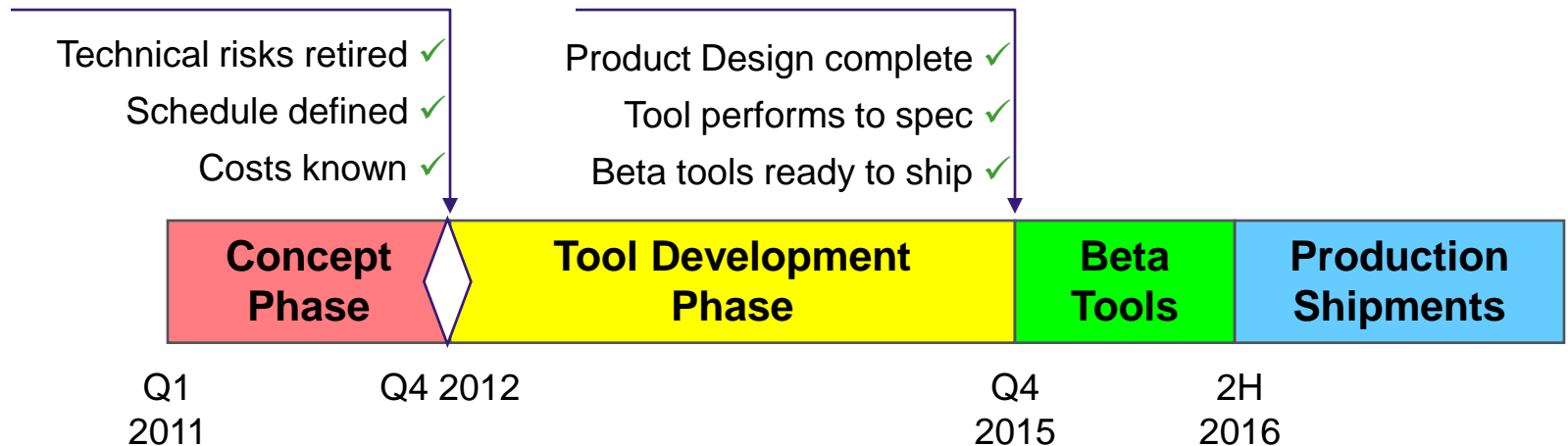
Benefits of Actinic Inspection Strategy

Phase defect & phase/pattern defect interaction – Ebeam cannot detect

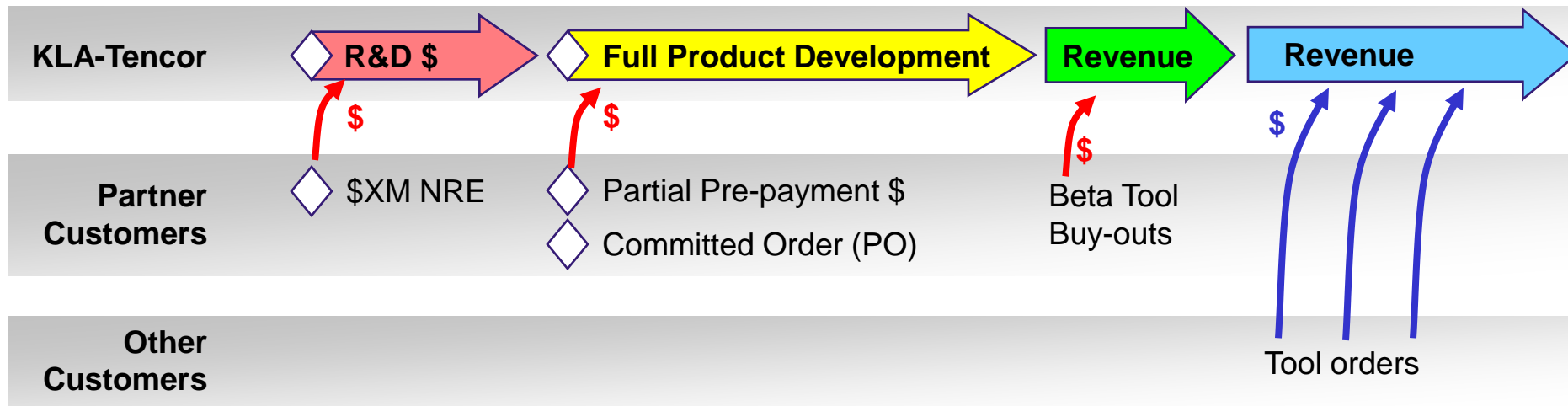


7XX Production Readiness Partnership

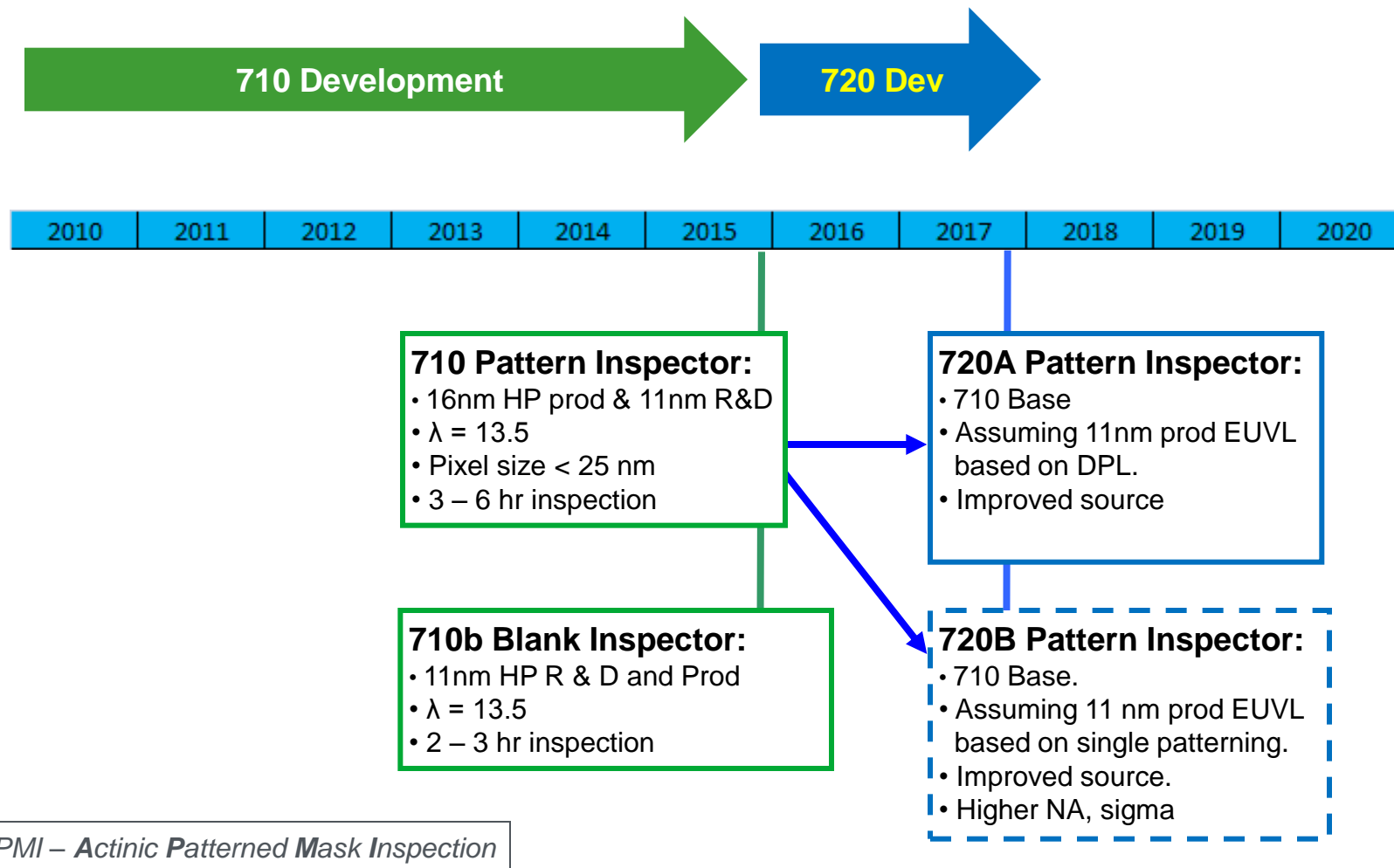
On schedule, multiple Partners participating



Go / No-Go?



Actinic 700-Series System Roadmap

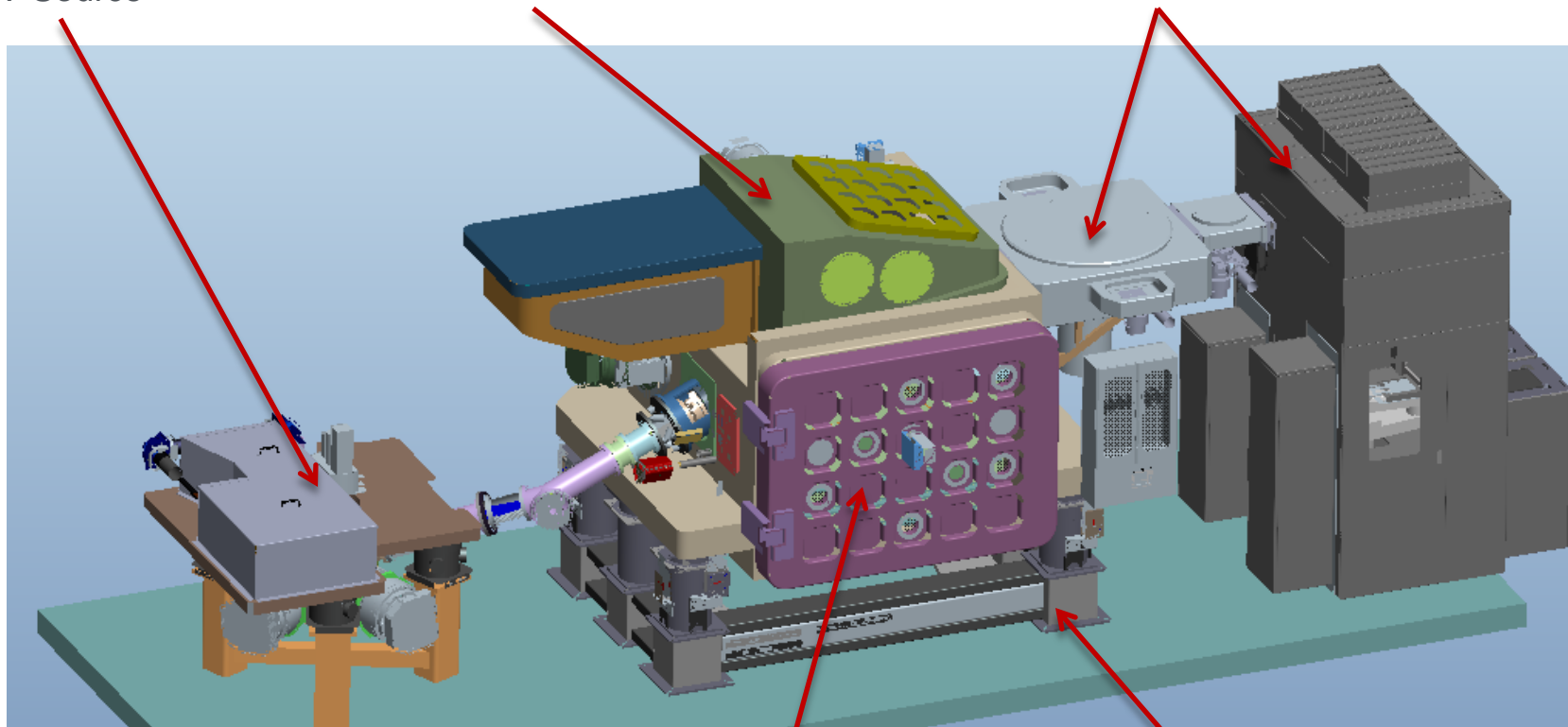


710 System Layout Concept

EUV Source

Reticle Stage Vacuum Chamber

Reticle Loading System

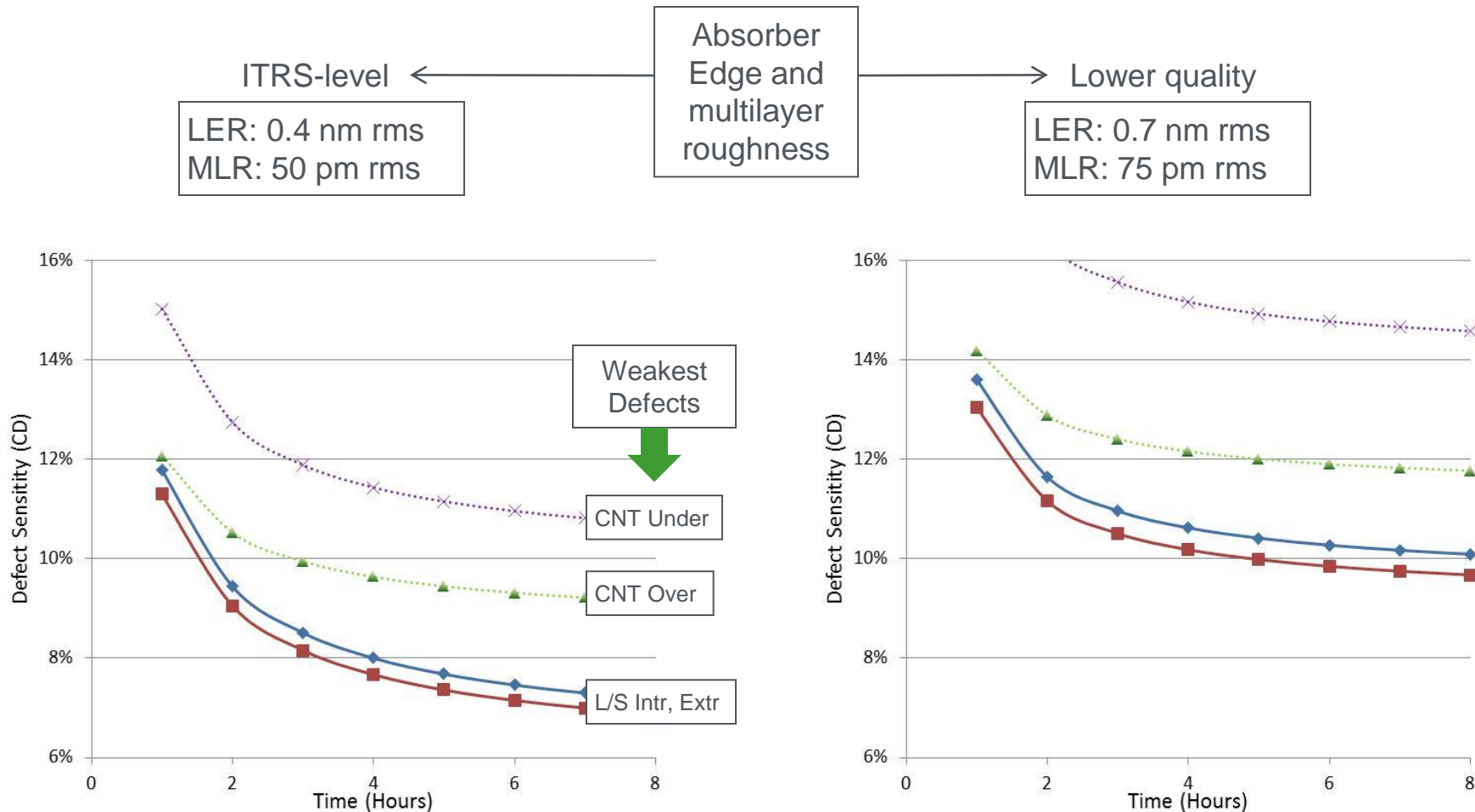


Module	Location	Length	Width	Height
7xx Tool	Fab	9.0 m	3.0 m	3.1 m
Auxiliary Modules	Sub-Fab	6.5 m	2.7 m	2.75 m
Outboard Electronic Units	Sub-Fab	10.3 m	3.4 m	2.1 m

Platform

710 performance estimate at 15nm HP

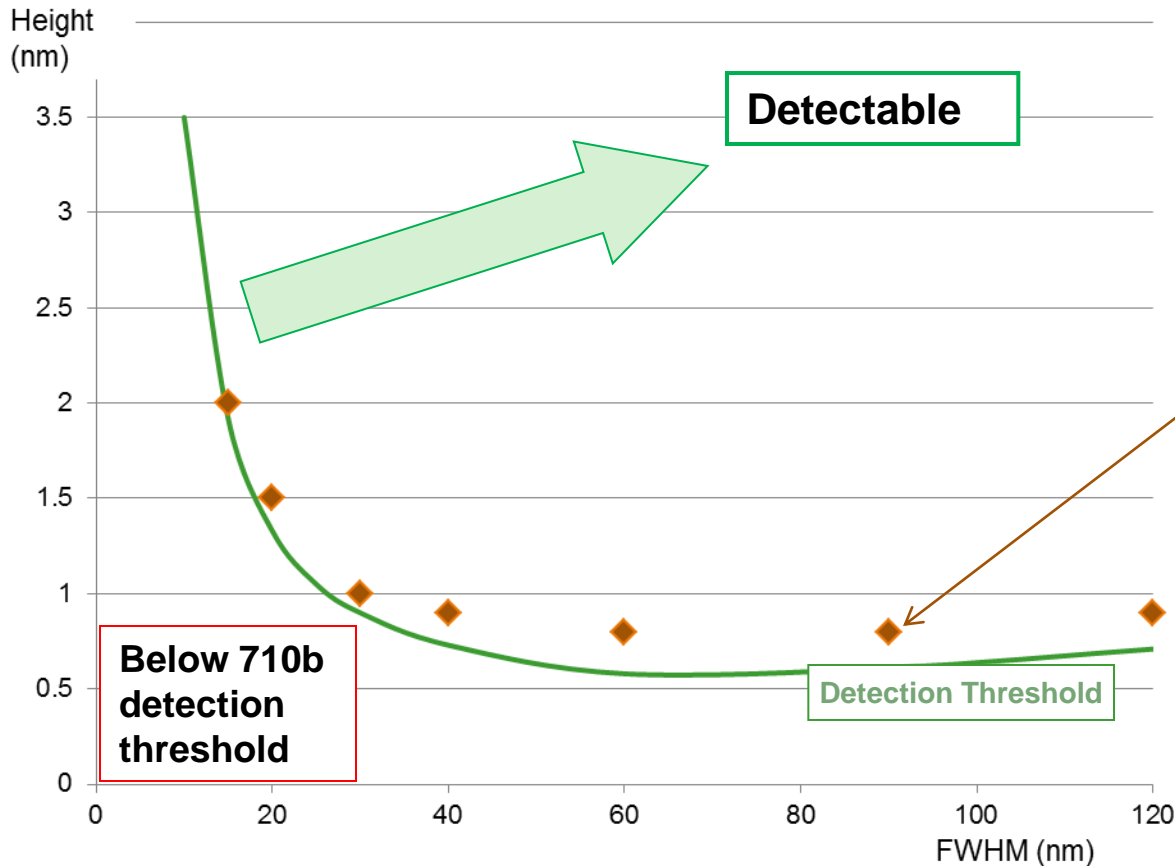
Simulations show impact of mask quality on performance



High-resolution actinic inspection architecture provides sensitivity and throughput

710B Performance Estimate – Phase Defects

Simulated performance meets 11 nm hp requirements



ML roughness 75 pm rms
Scan Area (134 mm)²
Scan Time ~ 2 hrs

10% Δ CD @ 11 nm node
Phase defect size “print-line”

SEVD (nm)	Height	FWHM
11	1.5	20
12.5	1.0	30
14.7	0.9	40
18.5	0.8	60
24	0.8	90
29.4	0.9	120

Actinic bright field inspection can detect phase defects causing 10% Δ CD @ 11nm HP

Summary

- Bridge tool solution based on proven 193 nm-based mask inspector successfully developed.
- Expected to meet 22 nm hp EUV HVM manufacturing requirements for both pattern and blank.
 - ✓ Sensitivity
 - ✓ Cleanliness
 - ✓ Throughput
- Platform can be extended to cover 18 nm hp EUV mask development
- Actinic platform development progressing to plan, no showstoppers
- Partnership in place.
- Decision in next 1-2 quarters to ramp into full development.
- Simulated performance expected to support 16 nm hp and below, blank and pattern inspection

Thank you for your attention!

